

Assignment 14.4

Questions 5, 93, 95, 98, 102, 104, 112, 129

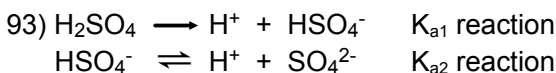
- 5) Salts can be acidic, basic or neutral because strong acids produce weak conjugate bases and weak acids produce strong conjugate bases. This is true for bases, but visa versa.

ex: **NH₄Cl** is an acidic salt

- NH₄⁺ is the strong conjugate acid of the weak base, NH₃.
- Cl⁻ is the weak conjugate base of the strong acid, HCl.

KF - is a basic salt

- K⁺ is the weak conjugate acid of the strong base, KOH.
- F⁻ is the strong conjugate base of the weak acid, HF.



95) a. $K_{a1} = \frac{[\text{H}^+][\text{H}_2\text{PO}_4^-]}{[\text{H}_3\text{PO}_4]} = 7.5 \times 10^{-3}$
 $\frac{x^2}{0.10 - x} = 7.5 \times 10^{-3}$
 $0 = 7.5 \times 10^{-4} - 7.5 \times 10^{-3}x - x^2$
 $x = 0.024\text{M}$ **pH = 1.62**

b. $K_{a1} = \frac{[\text{H}^+][\text{HCO}_3^-]}{[\text{H}_2\text{CO}_3]} = 4.3 \times 10^{-7}$
 $\frac{x^2}{0.10} = 4.3 \times 10^{-7}$
 $x = 2.1 \times 10^{-4}\text{M}$
pH = 3.68

- 98) K_{a1} is very high, so $[\text{H}^+] = 0.0050\text{M}$ (from H_2SO_4)

$$K_{a2} = 1.2 \times 10^{-2} = \frac{[\text{H}^+][\text{SO}_4^{2-}]}{[\text{HSO}_4^-]}$$

$$0.012 = \frac{(0.0050 + x)x}{(0.0050 - x)}$$

$$0.000060 - 0.012x = 0.0050x + x^2$$

$$0 = -0.000060 + 0.017x + x^2$$

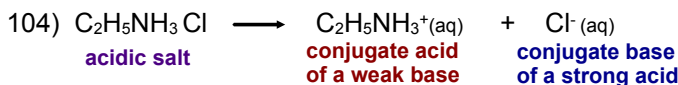
$$x = 0.0030\text{M} \text{ (from } \text{HSO}_4^- \text{)}$$

$$[\text{H}^+] = 0.0050 + 0.0030 = 0.0080\text{M}$$

pH = 2.10

Note: we had to account for H⁺ produced by H_2SO_4 and HSO_4^-

- 102) Since methylamine is a stronger base than ammonia (higher K_b value), ammonia's conjugate acid (NH₄⁺) is a stronger acid than methylamine's conjugate acid (CH₃NH₃⁺)



$$\text{C}_2\text{H}_5\text{NH}_3^+ \rightleftharpoons \text{C}_2\text{H}_5\text{NH}_2 + \text{H}^+$$

$$\frac{0.25\text{M}}{1.79 \times 10^{-11}} = \frac{x^2}{0.25}$$

$$x = 2.1 \times 10^{-6}\text{M}$$

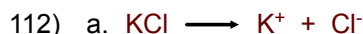
$$K_a \cdot K_b = K_w$$

$$K_a(5.6 \times 10^{-4}) = 10^{-14}$$

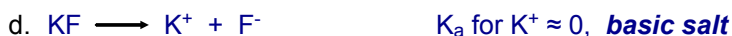
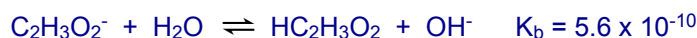
$$K_a = 1.79 \times 10^{-11}$$

[C₂H₅NH₃⁺] = 0.25M **[C₂H₅NH₂] = 2.1 × 10⁻⁶ M**
[Cl⁻] = 0.25M **[H⁺] = 2.1 × 10⁻⁶ M** **[OH⁻] = 4.8 × 10⁻⁹ M**

K_a and K_b for conjugates can be found by using $K_a \times K_b = K_w$



KCl is **neutral** (conjugates of strong acid and strong base)



- 129) 1. The pH is below 7, so we can eliminate any bases or basic salts (NaOH, NH_3 and NaCN)
2. The solution has high conductivity, so we can eliminate any weak acids (HCN and HF)
3. A 1.0M solution of a strong acid would have a pH of 0, so we can eliminate HCl.

By process of elimination, the solution is **NH_4Cl** , but we can check just because it's fun.

	$[NH_4^+]$ (M)	$[H^+]$ (M)	$[NH_3]$ (M)
I	1.0	0	0
C	- x	+ x	+ x
E	1.0 - x	x	x

$$K_a = \frac{[H^+][NH_3]}{[NH_4^+]} = 5.6 \times 10^{-10}$$

$$\frac{x^2}{1.0} = 5.6 \times 10^{-10}$$

$$x = 2.4 \times 10^{-5} M$$

$$pH = 4.6$$